PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-091207
(43)Date of publication of application : 31.03.2000

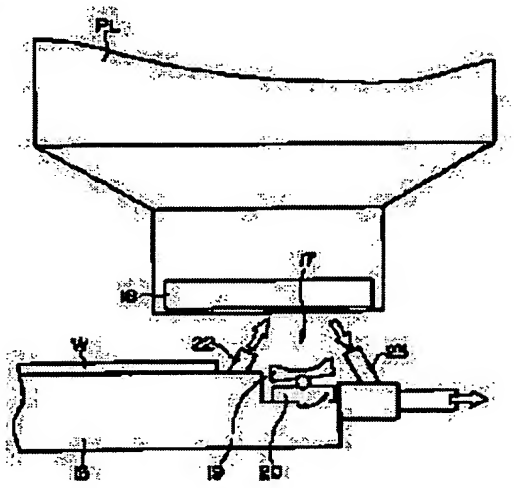
(51)Int.Cl. H01L 21/027
B08B 5/02
B08B 5/04
G02B 7/182
G03F 7/20

(21)Application number : 10-259719
(22)Date of filing : 14.09.1998

(71)Applicant : NIKON CORP
(72)Inventor : TOKUDA KENSHO

(54) PROJECTION ALIGNER AND CLEANING METHOD OF PROJECTION OPTICAL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To remove cleanly and effectively contaminants sticking on the surface of an optical element of a projection optical system.
SOLUTION: There is provided on a wafer table 15 a concave mirror 19 for reflecting the light (ultraviolet ray) emitted from a projection optical system PL toward an optical element (lens, etc.), 18 of a plurality of optical elements constituting the projection optical system PL which is closest to the image surface of the projection optical system PL. By changing the direction of the concave mirror 19 through a swing device 20, and by scanning with the reflection light of the concave mirror 19 the surface of the optical element 18, the contaminants on the surface of the optical element 18 are decomposed and vaporized to remove therefrom. A gas containing ozone is jetted from a jet nozzle 22 to suck the gas containing the vaporized contaminants in a suction nozzle 23.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] A projection aligner characterized by preparing a reflective member which reflects light injected from said projection optics towards an optical element nearest to the image surface of said projection optics in a projection aligner which projected on a substrate an image of a pattern of a mask illuminated by illumination light according to projection optics among two or more optical elements which constitute this projection optics.
[Claim 2] Said reflective member is a projection aligner according to claim 1 characterized by being a concave mirror.
[Claim 3] Said concave mirror is a projection aligner according to claim 2 characterized by being prepared on a substrate stage holding said substrate.
[Claim 4] Said concave mirror is a projection aligner according to claim 3 characterized by being removable on said substrate stage.
[Claim 5] Said concave mirror is a projection aligner according to claim 2 characterized by being supported by neck swing equipment so that the surface by the side of this concave mirror of said optical element may be scanned by the reflected light by this concave mirror.
[Claim 6] Said illumination light is a projection aligner according to claim 2 characterized by being ultraviolet rays.
[Claim 7] A projection aligner according to claim 2 characterized by forming a gas aspirator which attracts a gas of a portion between said optical elements and said concave mirrors.
[Claim 8] A projection aligner according to claim 2 characterized by forming gas blow off which spouts a gas into a portion between said optical elements and said concave mirrors.
[Claim 9] Said gas blow off is a projection aligner according to claim 8 characterized by spouting activated gas or inert gas.
[Claim 10] A washing method of projection optics characterized by reflecting light injected from said projection optics towards an optical element nearest to the image surface of said projection optics in a washing method of projection optics which projects on a substrate an image of a pattern of a mask illuminated by illumination light among two or more optical elements which constitute this projection optics, and carrying out optical washing of the surface of this optical element.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the projection aligner for manufacturing micro devices, such as image sensors, such as a semiconductor device, a liquid crystal display, and CCD, and the thin film magnetic head, and the washing method of projection optics.
[0002]
[Description of the Prior Art] the light source of the projection aligner used in a photolithography production process with progress of the high integration in micro devices, such as a semiconductor device, — the short-wavelength-izing — progressing — **** — the so-called vacuum ultraviolet radiation (wavelength of 248nm), for example, KrF excimer laser, and ArF excimer laser (wavelength of 193nm) — further — F2 Light, such as laser (wavelength of 157nm), has come to be used as a light for exposure.
[0003] In the photoresist which uses as a principal component the novolak resin generally used for the conventional i line etc. as a photoresist applied on the substrates (a semiconductor wafer, glass plate, etc.) in such a short wavelength field, since it becomes opaque, it cannot be used, but instead, the chemistry amplification mold resist is used.
[0004]
[Problem(s) to be Solved by the Invention] However, it was decomposed chemically, and the organic substance contained in a chemistry amplification mold resist by the exposure since it has very high energy gasified the light of this short wavelength region, and it produced the problem of polluting the lens surface, by condensing and adhering on the surface of the lens of the side nearest to this substrate of projection optics with which this counters a substrate and is arranged.
[0005] if this kind of contamination occurs, while the light transmittance of projection optics falls, the exposure time will become long since it is reservation of proper light exposure, and becoming the cause of reducing a throughput — since [— for example, there may be much coating weight of the center section of the lens —] the contamination on the surface of a lens is not uniform — lighting unevenness — being generated — high quality and high — there was a problem that where of a reliable micro device may be unable to be manufactured.
[0006] In addition, although the equipment which wipes off this pollutant mechanically is proposed, in order that a brush etc. may contact an optical element, there is a problem that an antireflection film etc. may be damaged.
[0007] The place which it is made in order that this invention may solve such a problem, and is made into the purpose is washing and removing effectively the pollutant adhering to the surface of the optical element of projection optics.
[0008]
[Means for Solving the Problem] Hereafter, in explanation shown in this term, although a reference mark shown in drawing of a gestalt of operation to each requirement for a configuration of this invention is attached and explained for easy-izing of an understanding, each requirement for a configuration of this invention is not limited by these reference marks.
[0009] A projection aligner of this invention for attaining the above-mentioned purpose is characterized by to prepare a reflective member (19) which reflects light injected from said projection optics towards an optical element (18) nearest to the image surface of said projection optics among two or more optical elements which constitute this projection optics in a projection aligner which projected an image of a pattern of a mask (R) illuminated by illumination light according to projection optics (PL) on a substrate (W).
[0010] Moreover, a washing method of projection optics of this invention for attaining the above-mentioned purpose In a washing method of projection optics (PL) which projects an image of a pattern of a mask (R) illuminated by illumination light on a substrate (W) It is characterized by reflecting light injected from said projection optics towards an optical element (18) nearest to the image surface of said projection optics among two or more optical elements which constitute this projection optics, and carrying out optical washing of the surface of this optical element.
[0011] Pollutants, such as the organic substance adhering to the surface of optical elements, such as a lens, can be removed by optical washing decomposed and evaporated by oxidizing with ozone or an excitation oxygen atom which was generated by UV irradiation or supplied separately a molecule of a pollutant with which association was dissociated while they cut a chemical bond by emitting ultraviolet rays.
[0012] So, in this invention, light injected from projection optics was turned to an optical element nearest to a substrate of this projection optics, and it reflected, and by leading to the surface of this optical element, optical washing of the surface of this optical element is carried out, and a pollutant was removed. since decline in light transmittance of projection optics is prevented, while a fall of a throughput is controlled by this, that lighting unevenness arises also prevents — having — high quality and high — a reliable micro device can be manufactured now.
[0013] In addition, since a concave mirror is employable, and light energy density in the surface of this optical element can be suitably set up highly, for example as a reflective member for leading light injected from projection optics to the surface of this optical element according to this concave mirror, time amount which optical washing takes can be shortened.
[0014]
[Embodiment of the Invention] Hereafter, with reference to a drawing, it explains per gestalt of operation of this invention. Drawing 1 is the outline block diagram of the contraction projection mold aligner (stepper) of the gestalt of operation of this invention.
[0015] In drawing 1 , the illumination-light study system 11 consists of optical integrators (homogenizer), such as the exposure light source, a fly eye lens for illumination distribution equalization, or a rod integrator which injects KrF excimer laser light (wavelength of 248nm), an illumination system aperture diaphragm, a reticle blind (adjustable field diaphragm), a condensing lens system, etc.

[0016] Adsorption maintenance is carried out on a non-illustrated reticle stage, and the reticle R as a photo mask with which the pattern which should be imprinted was formed is carried in to a predetermined reticle setting location at the time of exposure processing, and is irradiated by the reticle R by which the illumination light was set as the reticle setting location by the illumination-light study system 11. In the illumination-light study system 11, the half mirror 12 which branches the laser beam from the exposure light source is formed, the laser beam which penetrated the half mirror 12 is used as illumination light as it is, and incidence of the laser beam reflected by the half mirror 12 is carried out to the amount sensor 13 of incident light. The detecting signal of the amount sensor 13 of incident light is sent to permeability detection equipment 14.
[0017] Through projection optics PL, the image of the pattern in the lighting field of Reticle R is contraction scale-factor 1/alpha (alpha is 4 or 5), and is projected on the surface of the wafer W with which the photoresist of a chemistry amplification mold was applied. The Z-axis is taken in parallel with the optical axis AX1 of projection optics PL hereafter, in a plane perpendicular to the Z-axis, in parallel with the space of drawing 1 , at right angles to the space of drawing 1 , a Y-axis is taken and the X-axis is explained.
[0018] Wafer W is held by negative pressure adsorption on a non-illustrated wafer holder, and adsorption maintenance of the wafer holder is carried out removable on the wafer table (substrate stage) 15. The wafer table 15 is installed through two or more actuators displaced to a Z direction on the X-Y stage. The wafer table 15 doubles the surface of Wafer W with the image surface of projection optics PL by controlling the focal location (location of optical-axis AX1 direction) and tilt angle of Wafer W by the autofocus method.
[0019] Near the wafer holder of the wafer table 15, the outgoing radiation quantity of light sensor (illuminance sensor) 16 is formed. By moving the wafer table 15, the outgoing radiation quantity of light sensor 16 is located in the projection field by projection optics PL, detects the quantity of light (illuminance) in the image surface of projection optics PL, and sends the detecting signal to permeability detection equipment 14. Permeability detection equipment 14 computes the light transmittance from the half mirror 12 to the outgoing radiation quantity of light sensor 16 based on the detecting signal from the amount sensor 13 of incident light, and the outgoing radiation quantity of light sensor 16.
[0020] By comparing the compound value by which storage maintenance was beforehand carried out with the permeability called for by permeability detection equipment 14, the adhesion condition of the pollutant of projection optics PL can be known. Based on change of such light transmittance, implementation of optical washing by the optical washing station mentioned later is controlled. In addition, the illuminance sensor (unevenness sensor) which detects the illuminance unevenness in the projection field of projection optics PL (illumination distribution) is formed on the wafer table 15, and you may make it control implementation of washing by the optical washing station mentioned later based on the generating condition of illuminance unevenness.
[0021] Next, an optical washing station is explained. On the wafer table 15, as an important section is expanded and shown in drawing 2 , the optical washing station 17 is formed. The optical washing station 17 is equipped with the concave mirror 19 as a reflective member which reflects the light injected from projection optics PL towards the optical elements (a lens, glass plate, etc.) 18 nearest to the image surface of projection optics PL among two or more optical elements which constitute projection optics PL.
[0022] With the gestalt of this operation, this concave mirror 19 is a concave mirror of the cylindrical mold which condenses the light IL 1 (it shall be parallel light with the gestalt of this operation) which it is injected from projection optics PL and carries out incidence to the concave mirror 19 concerned on that axis AX2, as shown in the perspective diagram of drawing 3 . This concave mirror 19 is supported by the wafer table 15 through neck swing equipment 20 so that this condensing shaft AX2 may carry out an abbreviation rectangular cross to a direction parallel to the optical axis AX1 of projection optics PL.
[0023] Moreover, the condensing shaft AX2 of a concave mirror 19 is set as the location estranged to the **** side of projection optics PL from the surface (exposure) which should wash the optical element (henceforth a washed optical element) 18 nearest to the image surface of projection optics PL.
[0024] in order that [thus,] making the condensing shaft AX2 of a concave mirror 19 estrange from the surface of the washed optical element 18, and locating it may prevent destruction of the antireflection film covered by washed optical element 18 the very thing by energy concentration, or its surface — it is — the alienation — an amount can fully prevent the failure concerned etc. and optical washing effectiveness is suitably determined that it will become the highest. In addition, as a concave mirror 19, you may be the spherical mirror which condenses the reflected light to one point. Moreover, the convex mirror which replaced with the concave mirror 19 and gave divergence to a plane mirror or the reflected light is also employable.
[0025] Neck swing equipment 20 is equipment for rocking a concave mirror 19 by predetermined angle within the limits with the non-illustrated stepping motor by which the actuation shaft was connected with this shaft 21 while supporting it for the shaft 21 prepared in the concave mirror 19 in one, enabling free rotation, as an important section is expanded and shown in drawing 4 . By energizing suitably to the stepping motor of neck swing equipment 20, the surface of the washed optical element 18 can be continuously scanned now by the reflected light according the orientation of a concave mirror 19 to modification 19, i.e., a concave mirror.
[0026] Again, drawing 2 is referred to. A concave mirror 19 is adjoined on the wafer table 15, it points to the washed optical element 18 aslant, and the jet nozzle 22 is formed. Non-illustrated gas blow off is connected to this jet nozzle 22, and predetermined gas blows off from this jet nozzle 22 towards the washed optical element 18.
[0027] According to the class (class of photoresist to be used) of pollutant which adheres to the washed optical element 18 which is applicable as jet gas, the wavelength of the illumination light, etc., it is selected suitably, and inert gas, such as an argon (Ar), or the activated gas containing ozone (O3) or oxygen (O2) can be adopted. Namely, what is necessary is just to avoid concomitant use of ozone in consideration of the time and effort which removal of the ozone in the surrounding bad influence and surrounding discharge place to resin components takes, when the thing in which ozone was made to mix will be used and such [on the contrary] a facilitatory effect will not be accepted, if an adhesion pollutant is the thing of a property in which a photolysis is promoted by mediation of ozone.
[0028] Moreover, since the ultraviolet rays itself carry out decomposition activation of the oxygen in atmospheric air in the case of ultraviolet rays with more short wavelength (for example, ArF excimer laser) and ozone is generated even if it is the case where mediation of ozone promotes a photolysis, supply of ozone does not not necessarily have necessity. With the gestalt of this operation, in order to use KrF excimer laser as an exposure light, the activated gas containing ozone shall be spouted.
[0029] Moreover, it is prepared in the location which counters on both sides of the jet nozzle 22 and concave mirror 19 of the wafer table 15 so that the suction nozzle 23 may point to the washed optical element 18 aslant, and it connects with a non-illustrated gas aspirator and this suction nozzle 23 can attract now the gas containing the jet gas from the jet nozzle 22 of the portion between the wafer table 15 and the washed optical element 18.
[0030] Reticle R is set as a reticle setting location as a deer is carried out and it is shown in drawing 5 (A). If exposure processing is

carried out to the wafer W with which the chemistry amplification mold resist was applied When the organic substance contained in a chemistry amplification mold resist by the exposure of the illumination light decomposes chemically, and serves as Gas G and this condenses and adheres to Wafer W on the surface of the washed optical element 18 countered and arranged As shown in drawing 5 (B), pollutant 18a adheres to the surface of the washed optical element 18.

[0031] Light transmittance falls, in order to secure proper light exposure, it will be necessary to increase the exposure time, and a throughput falls according to generating of such contamination. Then, it asks for light transmittance with permeability detection equipment 14, and optical washing by the optical washing station 17 is performed. That is, the outgoing radiation quantity of light sensor 16 is set as the projection location (directly under [of an optical axis AX1]) of projection optics PL, and when the permeability computed by permeability detection equipment 14 from the detecting signal of the amount sensor 13 of incident light and the outgoing radiation quantity of light sensor 16 becomes smaller than the compound value by which storage maintenance was carried out beforehand (for example, when it becomes clear that it became 90%), optical washing by the optical washing station 17 is performed.

[0032] First, the wafer table 15 is moved, a concave mirror 19 is located under the washed optical element 18, the exposure light source of the illumination-light study system 11 is operated, and the lighting for optical washing is started. In addition, at this time, an illumination system aperture diaphragm etc. shall be suitably adjusted so that Reticle R may not be set as a reticle setting location and the incident light of the outline parallel light may be carried out from projection optics PL. While getting mixed up simultaneous in be fastidious, operating gas blow off and a gas aspirator and spouting predetermined gas from the jet nozzle 22, gas is attracted from the suction nozzle 23.

[0033] Next, neck swing equipment 20 is operated, the orientation of a concave mirror 19 is changed gradually and the surface of the washed optical element 18 is scanned by the reflected light (ultraviolet rays) by this concave mirror 19. Thereby, while cutting chemical bonds, such as the organic substance of the surface of the washed optical element 18, by oxidizing by the ozone which generated the molecule of the organic substance with which association was dissociated by the ozone in the activated gas from the jet nozzle 22, or UV irradiation, the organic substance is decomposed and evaporated and is removed. The evaporated pollutant is attracted by the suction nozzle 23 with a surrounding gas.

[0034] According to the gestalt of operation of this invention mentioned above, the ultraviolet rays injected from projection optics PL are reflected towards the washed optical element 18 with the concave mirror 19 supported by neck swing equipment 20, and it is made to carry out optical washing of the pollutant adhering to the surface of this optical element 18 by scanning the surface of this washed optical element 18. since decline in the light transmittance of projection optics PL is prevented, while the fall of a throughput is controlled by this, that lighting unevenness arises also prevents — having — high quality and high — a reliable micro device can be manufactured now.

[0035] Moreover, since it was made to reflect the ultraviolet rays injected from projection optics PL with a concave mirror 19, the light energy density of the ultraviolet rays in the surface of the washed optical element 18 is high, and the time amount which washing takes is short.

[0036] Furthermore, since the pollutant evaporated by the suction nozzle 23 is included and the nearby gas was attracted and removed while decomposition and evaporation of a pollutant were promoted, since it was made to spout the activated gas which contains ozone from the jet nozzle 22 at the time of implementation of optical washing, it is prevented after optical washing termination that a pollutant carries out the reattachment to the washed optical element 18.

[0037] In addition, since the orientation of a concave mirror 19 is changed with neck swing equipment 20 and the surface of the washed optical element 18 was scanned, the whole surface of the washed optical element 18 can be washed. Moreover, since it was made to carry out optical washing by the optical washing station 17 when the amount sensor 13 of incident light, the outgoing radiation quantity of light sensor 16, and permeability detection equipment 14 detected light transmittance and light transmittance became lower than the threshold value decided beforehand, it can wash, only when washing is required and washing with high effectiveness can be performed.

[0038] In addition, of course, configurations various in the range which this invention is not limited to the gestalt of above-mentioned operation, and does not deviate from the summary of this invention can be taken.

[0039] For example, although the projection aligner of the gestalt of this operation is the stepper of an one-shot exposure mold, it is applicable also like the aligner of the form of the scanning stepper of a scan exposure mold, or others. Moreover, it is not limited to KrF excimer laser (wavelength of 248nm), but the illumination light for exposure is ArF excimer laser (wavelength of 193nm), and F2. You may be any of higher harmonics, such as excimer laser (wavelength of 157nm), or an YAG laser. Moreover, while making into the illumination light for exposure EUV (Extreme Ultra Violet) light which has an oscillation spectrum in 5-15nm (soft-X-ray field), for example and specifying the lighting field on a reflective mask in the shape of a circle slit It has the contraction projection optics which consists only of two or more reflected light study elements (mirror), and this invention can be applied to the EUV aligner which carries out the synchronized drive of a reflective mask and the wafer with the velocity ratio according to the scale factor of contraction projection optics, and imprints the pattern of a reflective mask on a wafer.

[0040] Moreover, in the gestalt of the above-mentioned operation, although the concave mirror 19, the neck swing equipment 20, the jet nozzle 22, and the suction nozzle 23 of the optical washing station 17 were prepared in the wafer table 15 fixed If it installs on the wafer table 15, optical washing can be performed and it does in this way when this invention does not need to be limited to this, but it is necessary to constitute it so that attachment and detachment of these all or parts may be attained, and optical washing needs to be performed, small [of a wafer table], lightweight-ization, etc. can be attained. Although it is desirable to install from a viewpoint of improvement in optical washing effectiveness and reattachment prevention of a pollutant as for gas blow off containing the jet nozzle 22, and the gas aspirator containing the suction nozzle 23, it is not necessarily indispensable, and it is also possible to omit either or both sides.

[0041] Furthermore, with the gestalt of the above-mentioned implementation, the condensing shaft AX2 of a concave mirror 19 was set up so that it might be estranged and located in the **** side of projection optics PL from the surface of the washed optical element 18, but it can set up so that it may be estranged and located in the image surface side of projection optics PL. It can be suitably selected according to the orientation of adhesion in the washed optical element 18 of a pollutant whether the surface of the washed optical element 18 is received and this condensing shaft AX2 is located in a gap side.

[0042] namely, the light energy density in the surface of the washed optical element 18 by the reflected light of a concave mirror 19 — the alienation from the condensing shaft AX2 of a concave mirror 19, since it is in inverse proportion to an amount As shown in drawing 5 (B), when there is much coating weight of the pollutant in the center section of the washed optical element 18 By setting the location of the condensing shaft AX2 to the image surface side of the washed optical element 18 Light energy density becomes

small as light energy density is high in the center section (side near a concave mirror 19) of the washed optical element 18 surface and it keeps away, and according to the actual condition of contamination, it can wash in efficient. on the other hand, by locating the condensing shaft AX2 of a concave mirror 19 in the **** side of the washed optical element 18, in many [contrary to drawing 5 (B), it is comparatively alike, and there are few contamination conditions in the center section, and / in a periphery], in a center section (side near a concave mirror 19), light energy density is low, and it keeps away — it is alike, and it will follow, light energy density will become high, and the actual condition of contamination will be met.

[0043] In addition, with the gestalt of the above-mentioned operation, although neck swing equipment 20 is made to perform the scan of the surface of the washed optical element 18 by the reflected light of a concave mirror 19, this invention is not limited to this, is used together with neck swing equipment 20, or is independent, and migration of the concave mirror 19 on the wafer table 15 can perform it.

[0044] Moreover, although neck swing equipment 20 shall change the orientation of a concave mirror 19 centering on one shaft (shaft 21), it is good for 2 shaft orientations also as that to which the orientation of a concave mirror 19 is changed. In addition, with the gestalt of the above-mentioned implementation, although detection of light transmittance was made to perform implementation of optical washing by the optical washing station 17, when the addition exposure time reaches predetermined time amount, it may be made to carry out optical washing.

[0045] furthermore, the gas which contains oxygen although the activated gas containing ozone is blown off with gas blow off and the photolysis was promoted with the gestalt of the above-mentioned operation — spouting — making — the inside of the jet nozzle 22 — or you may make it generate ozone by preparing a corona discharge electrode in a point

[0046]

[Effect of the Invention] Since this invention was constituted as explained above, it is effective in the ability to wash and remove effectively the pollutant adhering to the surface of the optical element of projection optics. Moreover, as compared with what is wiped off and washed with a brush etc., it is effective in the ability to prevent damage on this optical element.

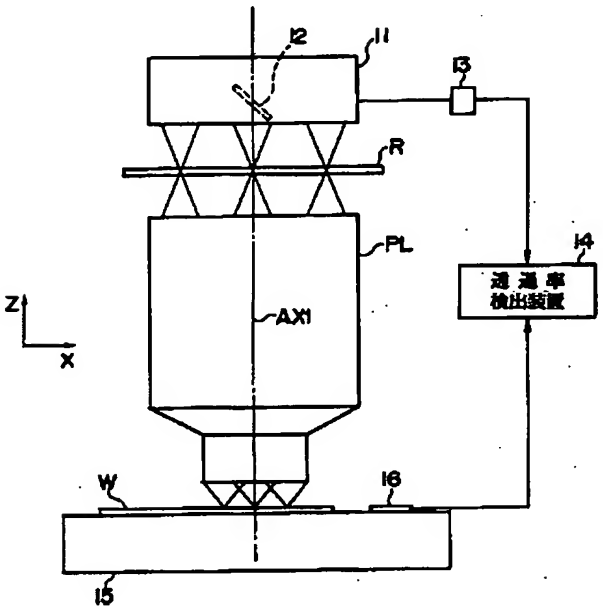
[Translation done.]

* NOTICES *

DRAWINGS

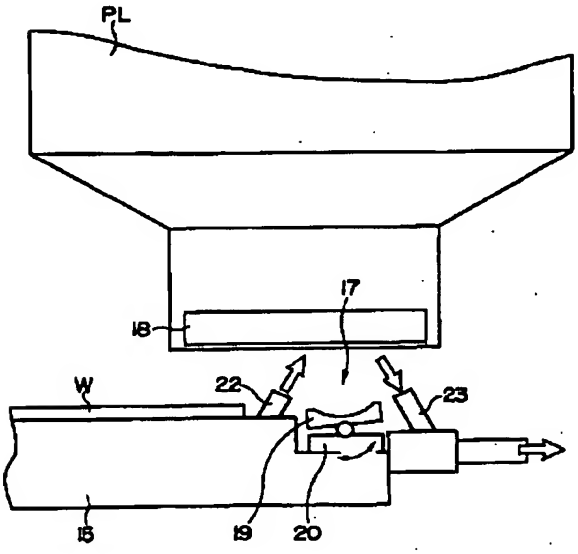
[Drawing 1]

図1



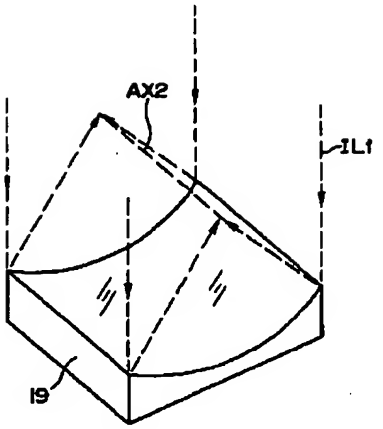
[Drawing 2]

図2



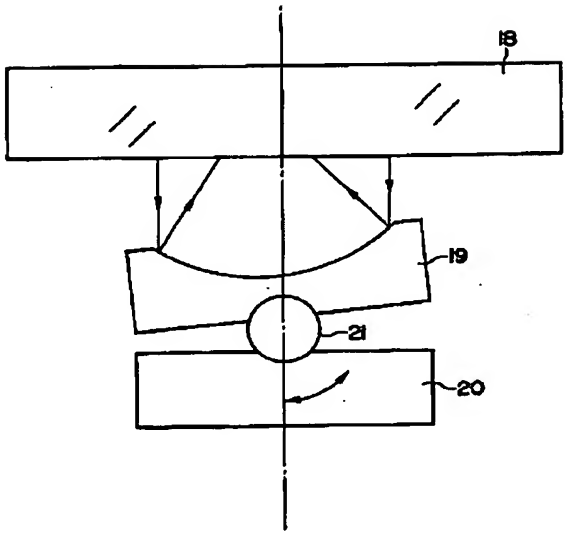
[Drawing 3]

図3



[Drawing 4]

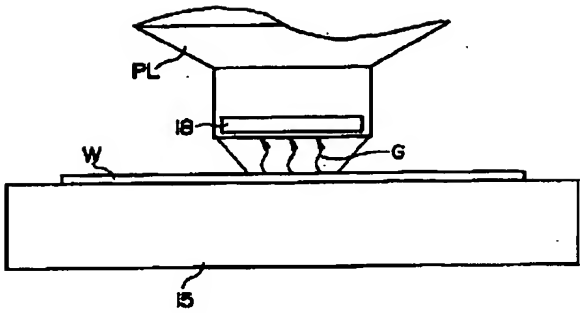
図4



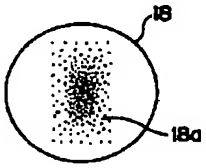
[Drawing 5]

図5

(A)



(B)



[Translation done.]